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Morphological and anatomical characteristics of some plant species of lauraceae family collected in inland sandy area of Phong Dien town, Hue city

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Abstract. This study examines with the morphological and anatomical characteristics of three species in the Lauraceae family that grow in the inland sandy area of Phong Dien Town, Hue City. The analysis reveals that all three species exhibit traits typical of strongly heliophilous plants, as reflected in the morphology and anatomy of their vegetative organs. Notable features include well-developed palisade parenchyma, a thick cork layer covering the stems and roots, providing thermal insulation, and numerous xylem vessels with narrow lumens, which enhance water absorption under arid conditions. The findings are valuable data for the botanical database of this ecologically unique region and provide a scientific basis for the conservation and restoration of plant cover in the inland sandy zones of the locality.

Keywords: morphology, anatomical plant, Lauraceae, inland sandy, Phong Dien

1 Introduction

The inland sandy land of Phong Dien Town, Hue City, lies on the west side of the Tam Giang – Cau Hai Lagoon, covering an area of 22,127 hectares [1]. This environment has distinct features: poor soil, sandy terrain, and saline and alum-contaminated water sources. The area is frequently affected by the foehn from Lao, and a harsh, dry season, along with high temperatures and strong sunlight [2]. Despite this fact, the area holds potential for relatively good vegetation development [3]. However, the vegetation in the area does not fully reflect the original tropical flora. Instead, it exhibits high adaptation, highlighting its ecological role in conservation, erosion prevention, and as a source of raw materials and food for the local population.

Lauraceae is one of the large families in the Magnoliophyta, a group of plants with high ecological and economic importance in tropical and subtropical regions. In Vietnam, more than 250 species of Lauraceae are found primarily in evergreen tropical forests, tropical moist forests, and secondary forests. Numerous Lauraceae species have crucial roles in forest ecosystems and are valuable both for their ecological functions and for their wood and medicinal properties [4]. Botanical studies on the inland sandy area of Phong Dien Town have documented the presence of species from the Lauraceae family [5], and several species have been investigated for their medicinal purposes [6]. Although studies have been conducted on the morphological and anatomical characteristics of various plant species, there remains a limited amount of research on species within this group. Therefore, this study was conducted to identify specific morphological and anatomical traits of particular species within this family that enable them to adapt to the inland

sandy habitat, thereby serving restoration and conservation strategies for the local dune vegetation.

2 Research subjects and methods

2.1 Research subjects

This study focuses on three species in the Lauraceae family: *Lindera myrrha* (Lour.) Merr., *Lindera aggregata* (Sims.) Kost., and. *Litsea glutinosa* (Lour.) C. B. Rob. These are common native species found in the inland sandy area of Phong Dien Town, Hue City.

2.2 Methods

Theoretical research

This study reviews and selectively synthesizes all available literature related to the vegetation of the inland sandy area in Phong Dien Town, Hue City, with particular emphasis on works concerning the Lauraceae family.

Field research

Field observations

External morphology and habitat conditions, such as tree height and leaf characteristics, were examined.

Sampling

Samples were collected following the method described by Nguyen [7]. All vegetative organs of the plants, namely roots, branches, and leaves, as well as reproductive organs, such as flowers and fruits (if available), were collected. For each species, between three and ten specimens were obtained. For structural and anatomical analysis, samples were selected, fixed, and preserved with standard techniques. Mature leaves were selected; transverse sections of the leaf blade were cut, and the sections were fixed. The sections were then stained, mounted, and measured to ensure consistency and comparability between samples.

Experimental method

Species identification was conducted on the basis of morphological characteristics and comparison with references [8, 9].

Anatomical structures of roots, stems, and leaves were examined by means of sectioning and staining techniques [7]. Thin transverse sections were prepared and subjected to double staining with Javel water, 1% hydrochloric acid, methylene blue, and carmine red to enhance the visualization of internal tissues. Stained samples were observed and measured under a light microscope equipped with an ocular micrometer. Measurements were repeated ten times to ensure accuracy. Microscopic images of vegetative organs were captured with either a detachable camera or a microscope with an integrated camera system.

Data were processed statistically with Microsoft Excel.

3 Results and discussion

The studied species were commonly found in the inland sandy land with both ecological and medicinal value. Two of them are shrubs, and one is a small tree.

3.1 Morphological and anatomical features of *Lindera myrrha* (Lour.) Merr.

External morphology

Lindera myrrha was collected in the inland sandy soil area of Phong Dien Town, Hue City. The species is a small shrub, 1.3–1.4 m high, with a 20–25 cm stem diameter. The stem bark is dark brown. Leaves are coriaceous, ovate, with an acuminate apex; the adaxial surface is dark green and glossy, whereas the abaxial surface is silvery

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and covered with fine pubescence (Fig. 1a). In sandy habitats, the species does not occur solitarily but is commonly distributed beneath the canopy of other woody species.

Anatomical features

Leaf cross-section

The leaf thickness averages are 148.19 ± 5.54 µm, composed of an upper epidermis, a thick palisade mesophyll layer, a spongy mesophyll layer, and a lower epidermis. (Table 1 and Fig. 1b).

The leaf is relatively thick, with tissue layers such as the epidermis, sclerenchyma, phloem, and xylem. Notably, a sclerenchymatous ring surrounds the vascular bundle, with an approximately 55.45 ± 1.75 µm thickness, reinforcing the leaf structure (Fig. 1c).

Table 1. Thickness and percentage of leaf tissue layers

Tissue layer	Thickness (µm)	Proportion (%)
Upper cuticle and epidermis	19.70 ± 1.08	13.30
Cutin and lower epidermis	16.03 ± 0.73	10.82
Palisade mesophyll	45.58 ± 2.53	30.76
Spongy mesophyll	66.88 ± 1.20	45.13
Total	**148.19**	**100.00**

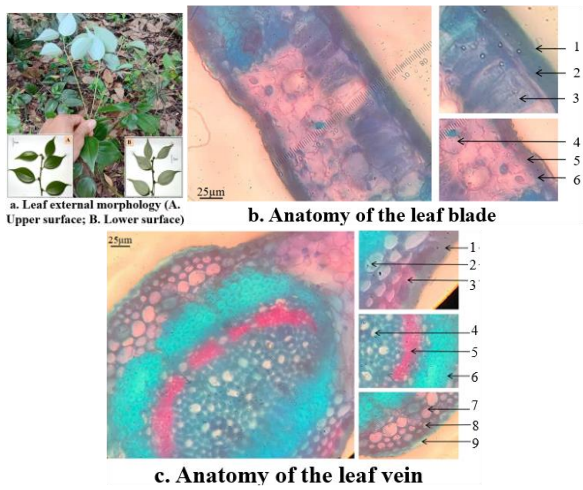

Fig. 1. External and anatomical structure of *Lindera myrrha* leaf
Fig. 1b: 1. Upper cuticle; 2. Upper epidermis; 3. Palisade mesophyll; 4. Spongy mesophyll; 5. Lower epidermis; 6. Lower cuticle. **Fig. 1c:** 1. Upper epidermis; 2. Parenchyma; 3. Palisade tissue; 4. Xylem; 5. Phloem; 6. Sclerenchyma; 7, 8. Collenchyma; 9. Lower epidermis

Stem and root anatomy

The anatomical organization of the stem and root can be divided into two main regions: the cortex and the stele. The cortical region comprises the periderm, collenchyma, sclerenchyma, and phloem layers, whereas the stele consists of xylem and pith.

In the stem, the pith occupies a substantial proportion, accounting for approximately 30.90% of the stem radius. By contrast, in the root, the pith is relatively reduced, representing only about

9.11% of the root radius. This structural difference enhances the mechanical strength of the root system, thereby facilitating soil penetration and improving its ability to explore water sources.

The proportions of each tissue layer in the stem and root are presented in Table 2, with anatomical images provided on Fig. 2.

Table 2. Anatomical measurements of *Lindera myrrha* stem and root

Tissue layer	**Stem**	
	Thickness (μm)	***Proportion (%) of the stem radius***
Cork layer	25.20 ± 2.84	1.72
Cortex	126 ± 3.25	8.60
Phloem	151.52 ± 2.40	10.38
Xylem	706.08 ± 4.65	
Number of xylem vessels /**mm²**	61.59 ± 0.96	48.40
Lumen size of xylem vessels	26.08 ± 4.08	
Pith	450.32 ± 5.76	30.90
Total	**1459.12**	**100**
Tissue layer	**Root**	
	Thickness (μm)	***Proportion (%) of the root radius***
Cork layer	135.30 ± 6.50	6.15
Cortex	206.12 ± 5.20	9.37
Phloem	158.20 ± 4.18	7.20
Xylem	1498.86 ± 7.65	
Number of xylem vessels /**mm²**	84.36 ± 1.00	68.17
Lumen size of xylem vessels	35.60 ± 8.36	
Pith	200.30 ± 5.85	9.11
Total	**2198.78**	**100**

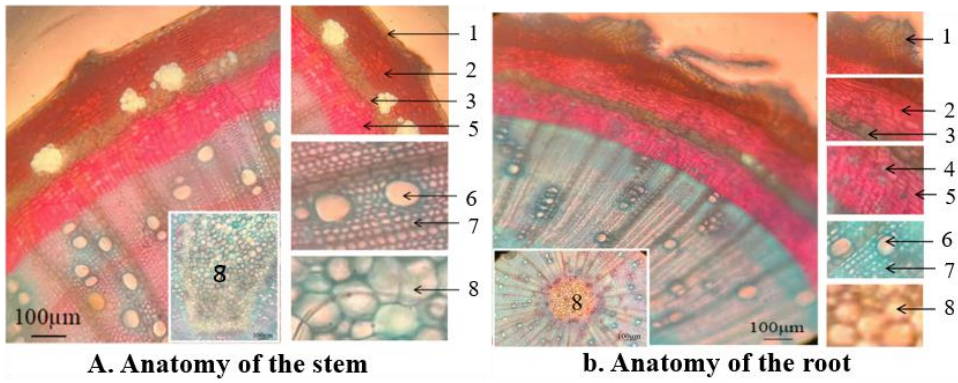

Fig. 2. Anatomical structure of *Lindera myrrha* stem and root
1. Cork; 2. Cortex; 3. Sclerenchyma ring; 4. Hard phloem; 5. Soft phloem; 6. Vascular bundle; 7. Xylem rays; 8. Pith

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3.2 Morphological and anatomical features of *Lindera aggregate* (Sims.) Kost.

External morphology

Lindera aggregata is commonly distributed in inland sandy areas. Similar to *Lindera myrrha*, this species exhibits a shrubby growth form and typically occurs beneath the canopy of larger woody plants. Individuals attain an average 1.5–2.0 m height, with stem diameters ranging from 7 to 10 cm. Young branches are light yellow and densely covered with fine trichomes, whereas mature branches become dark brown and glabrous. Leaves are alternately arranged, relatively small, and ovate in shape, 1.5–3.0 cm wide, and 3.5–4.5 cm long. The adaxial surface is dark green and glossy, while the abaxial surface is characterised by a silvery sheen (Fig. 3a).

Anatomical features

Leaf cross-section

The average thickness of *Lindera aggregata* leaves is about 174.28 ± 1.85 µm. The upper cuticle and epidermis account for approximately 9.31% of total leaf thickness. The palisade mesophyll accounts for about 32.53%, and the spongy mesophyll accounts for about 50.44%. (Table 3 and Fig. 3b)

Table 3. Thickness and percentage of leaf tissue layers

Tissue layer	Thickness (µm)	Proportion (%)
Upper cuticle and epidermis	16.23 ± 0.85	9.31
Cutin and lower epidermis	13.45 ± 0.65	7.72
Palisade mesophyll	56.70 ± 1.53	32.53
Spongy mesophyll	87.90 ± 1.05	50.44
Total	**174.28**	**100.00**

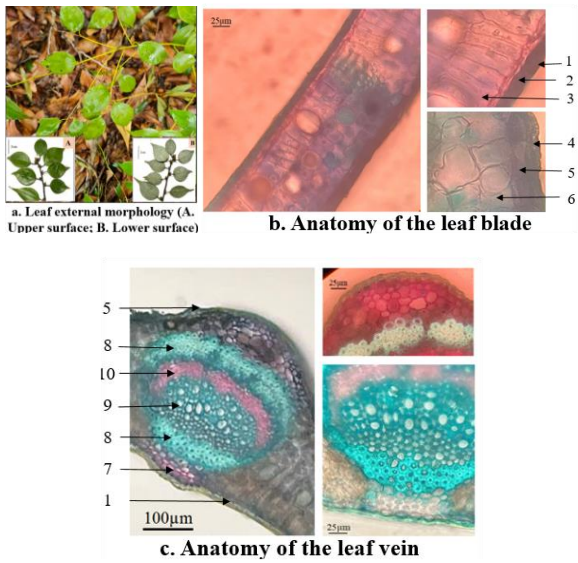

Fig. 3. External and anatomical structure of *Lindera aggregate* leaf
1. Upper cuticle; 2. Upper epidermis; 3. Palisade mesophyll; 4. Lower cuticle; 5. Lower epidermis; 6. Spongy mesophyll; 7. Collenchyma; 8. Sclerenchyma; 9. Xylem; 10. Phloem

Stem and root anatomy

Quantitative data on the thickness and relative proportions of tissue layers in the stem and root of *Lindera aggregata* are presented in Table 4 and illustrated on Fig. 4.

According to Table 4, the xylem occupies a substantial portion of the root and stem. Notably, in the root, it constitutes 77.41% of the radius, and pith parenchyma cells are absent. This anatomical adaptation enhances root rigidity, facilitating its penetration through sandy substrates in the search for water.

Table 4. Anatomical measurements of *Lindera aggregate* stem and root

Tissue layer	**Stem**	
	Thickness (µm)	***Proportion (%) of the stem radius***
Cork layer	57.10 ± 4.32	2.80
Cortex	350.45 ± 3.95	17.15
Phloem	172.20 ± 2.72	8.43
Xylem	963.38 ± 4.08	
Number of xylem vessels /**mm²**	76.63 ± 2.09	47.15
Lumen size of xylem vessels	14.00 ± 1.72	
Pith	500.12 ± 7.40	24.47
Total	**2043.25**	**100**
Tissue layer	**Root**	
	Thickness (µm)	***Proportion (%) of the root radius***
Cork layer	54.72 ± 3.60	2.46
Cortex	216.29 ± 4.20	9.85
Phloem	225.80 ± 3.18	10.28
Xylem	1699.16 ± 7.65	
Number of xylem vessels /**mm²**	92.81 ± 0.67	77.41
Lumen size of xylem vessels	11.72 ± 2.32	
Pith	0	0
Total	**2195.97**	**100**

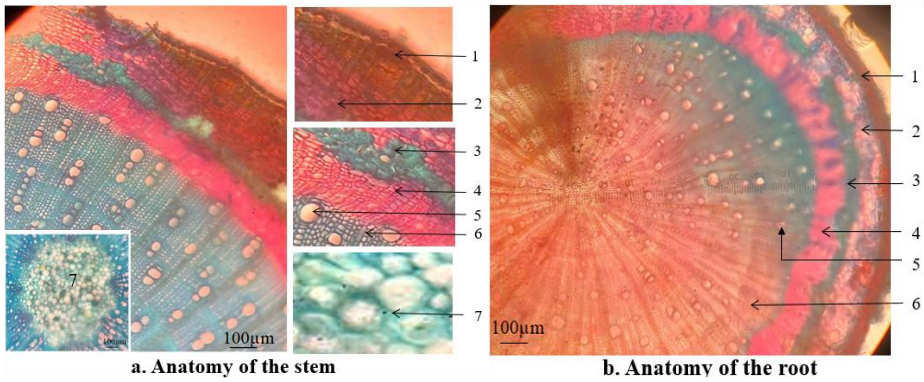

Fig. 4. Anatomical structure of *Lindera aggregate* stem and root
1. Cork; 2. Cortex; 3. Sclerenchyma ring; 4. Phloem; 5. Vascular bundle; 6. Xylem rays; 7. Pith

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3.3 Morphological and anatomical features of *Litsea glutinosa* (Lour.) C. B. Rob.

External morphology

Litsea glutinosa is a woody species and is widely distributed in inland sandy areas. The tree typically attains an 8–10 m height, with 15–30 cm stem diameters. The bark colour is brown to gray. Leaves are ovate, relatively large in size, 3–6 cm wide, and 8–11 cm long. They are alternately arranged and usually clustered at the ends of branches. The adaxial surface is smooth, glossy, and dark green, whereas the abaxial surface is lighter green and covered with fine hairs (Fig. 5a).

Anatomical features

Leaf cross-section

With a thickness of 200.26 ± 8.8 μm, the leaf blade consists of distinct anatomical components such as the cuticle layer, epidermis, and mesophyll. Detailed measurements and proportional data of these layers are provided in Table 5, and the structural organization is shown on Fig. 5b.

Table 5. Thickness and percentage of leaf tissue layers

Tissue layer	Thickness (μm)	Proportion (%)
Upper cuticle and epidermis	13.25 ± 0.98	6.62
Cutin and lower epidermis	11.63 ± 0.97	5.81
Palisade mesophyll	97.63 ± 2.28	48.75
Spongy mesophyll	77.75 ± 4.58	38.82
Total	**200.26**	**100.00**

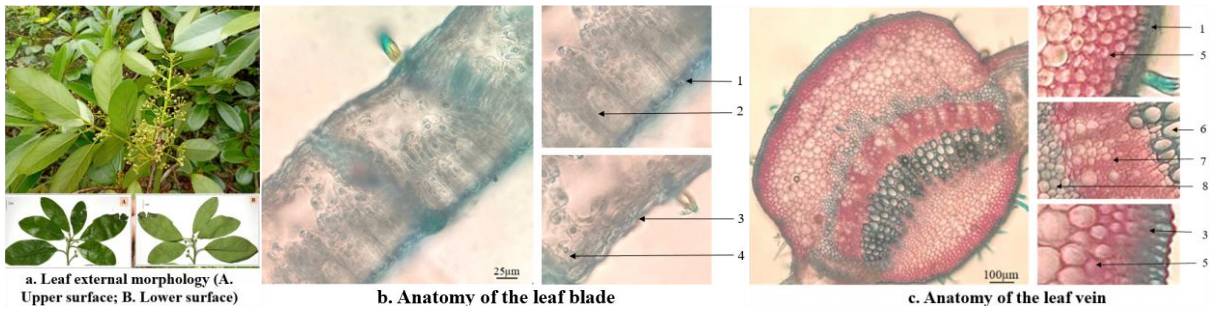

Fig. 5. External and anatomical structure of *Litsea glutinosa* leaf
1. Upper epidermis; 2. Palisade mesophyll; 3. Lower epidermis; 4: Spongy mesophyll; 5. Collenchyma; 6. Xylem; 7. Phloem; 8: Sclerenchyma

Stem and root anatomy

The anatomical structures of the stem and root of *Litsea glutinosa* exhibit notable differences. In the stem, the cork layer is relatively thin, accounting for only 0.7% of the stem radius. In contrast, in the root, this layer is more pronounced, occupying approximately 3.28% of the root radius. Although the number of xylem vessels is high in both organs, differences in the vessel lumen diameter were observed. The average vessel lumen diameter in the stem is 25.90 μm, while in the root it is significantly smaller, measuring only 13.75 μm (see Table 6 and Fig. 6).

Table 6. Anatomical measurements of the stem and root of *Litsea glutinosa*

Tissue layer	Stem	
	Thickness (µm)	*Proportion (%) of the stem radius*
Cork layer	22.00 ± 2.70	0.7
Cortex	951.4 ± 5.60	29.78
Phloem	475.70 ± 6.30	14.80
Xylem	1327.1 ± 5.40	
Number of xylem vessels /**mm²**	129.30 ± 5.55	41.52
Lumen size of xylem vessels	25.90 ± 1.15	
Pith	422.05 ± 2.80	13.20
Total	**3195.25**	**100**
Tissue layer	**Root**	
	Thickness (µm)	*Proportion (%) of the root radius*
Cork layer	102.30 ± 5.60	3.28
Cortex	595.86 ± 4.35	19.10
Phloem	484.30 ± 6.70	15.52
Xylem	1937.2 ± 5.25	
Number of xylem vessels /**mm²**	112.20 ± 5.80	62.10
Lumen size of xylem vessels	13.75 ± 0.83	
Pith	0	0
Total	**3119.66**	**100**

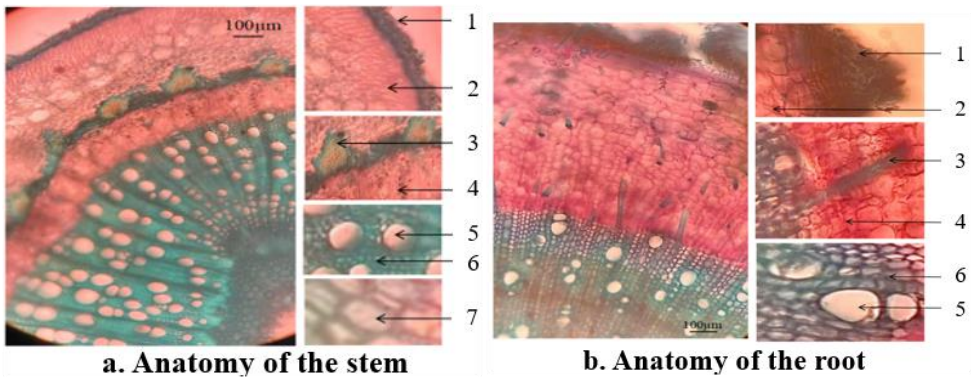

Fig. 6. Anatomical structure of *Litsea glutinosa* stem and root
1. Cork; 2. Cortex; 3. Sclerenchyma ring; 4. Phloem; 5. Vascular bundle; 6. Xylem rays; 7. Pith

3.4 Discussion on adaptive traits of species to their habitat

Through the morphological and anatomical investigations conducted in this study, we observed that all species exhibit a range of adaptive traits that reflect their response to environmental conditions. These adaptations are evident in both external morphology and internal anatomical structure.

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Leaf morphology and anatomy

All studied species possess thick, rigid leaves with glossy upper surfaces and silvery, often pubescent lower surfaces. Anatomically, the leaves are covered by a thick cuticle layer on both surfaces. The palisade mesophyll occupies a substantial proportion of the leaf blade: *Litsea glutinosa* 48.75%, *Lindera aggregata* 32.53%, and *Lindera myrrha* 30.76%. The vascular system in the leaves is well-developed, particularly in *Lindera myrrha* and *Lindera aggregata*, where a prominent sclerenchyma ring surrounds the vascular bundles, offering mechanical protection against harsh conditions in sandy soils. These leaf traits are characteristic of heliophilous species, which explains their widespread distribution in sandy environments.

Stem and root morphology and anatomy

The stems and roots of the species are externally protected by a thick cork layer, which provides thermal insulation and safeguards against high temperatures. The xylem system is dense, yet the vessel lumens are relatively small—an anatomical configuration that facilitates greater water absorption under drought conditions. This characteristic is particularly advantageous in sandy soils, where water availability is limited.

Regarding the above characteristics, all three species can be classified as heliophilous and drought-tolerant. Furthermore, slight variations in morphological traits were observed as part of the species' adaptive response to the sandy environment. For instance, *Litsea glutinosa*, typically described in literature sources [8, 9] as a medium to large-sized tree, is found only in the form of small trees under the nutrient-poor and climatically harsh conditions of sandy areas. Similarly, while *Lindera myrrha* and *Lindera aggregata* are generally considered small trees in other regions, they occur as small shrubs growing beneath the canopy of other species in the sandy habitat. These minor morphological shifts demonstrate how the species have adjusted their growth forms to better cope with the environmental stresses of their habitat.

4 Conclusions

Based on the analysis of the morphological and anatomical characteristics of plant species in the Lauraceae family, we can draw the following conclusions:

All studied species exhibit traits typical of heliophilous plants, such as small, thick, and rigid leaves (*Lindera myrrha* and *Lindera aggregata*), with smooth upper surfaces and silvery, reflective lower surfaces. These features enhance light reflection and minimize heat absorption. In contrast, *Litsea glutinosa* has larger leaves, which are densely covered with trichomes on both surfaces. All species possess wide canopies with branching beginning near the base, contributing to efficient light capture.

Light-adapted features are clearly expressed in leaf anatomy through a thick cuticle layer covering both surfaces, which helps reduce water loss. The palisade mesophyll is well-developed, occupying a significant portion of the leaf blade. *Litsea glutinosa*, which grows in more open and sunlit environments, exhibits the highest proportion of palisade mesophyll (48.75% of total leaf thickness). In contrast, *Lindera myrrha* and *Lindera aggregata*, which tend to grow under the canopy of other species, receive less direct light and therefore have a lower proportion of palisade mesophyll.

In both stem and root anatomy, a well-developed cork layer provides insulation and protection against high temperatures typical of sandy habitats. The xylem is dense, and the xylem vessels have relatively small lumen diameters, a structural adaptation that enhances water uptake efficiency under drought-prone conditions.

These morphological and anatomical traits highlight the species' strong adaptations to high light intensity and water scarcity, allowing them to survive and thrive in the harsh conditions of inland sandy environments.

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